

December 2011 MSS/LPS/SPS Joint Subcommittee Meeting

ABSTRACT SUBMITTAL FORM

The submission of an abstract is an agreement to complete a final paper for publication and attend the meeting to present this information. Complete all information requested in the author and co-author information sections; the first author listed will receive paper acceptance notices and all correspondence. Abstracts must be submitted electronically; submittal instructions are located in the call for papers. **The abstract deadline date is June 13, 2011.**

ABSTRACT INFORMATION

Title: Analyses of Injection-Coupled Combustion Instability From J-2X Gas Generator Development

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MANAGEMENT APPROVAL

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ABSTRACT SUBMITTAL FORM

Unclassified Abstract

(250-300 words; do not include figures or tables)

During development of the gas generator for the liquid oxygen/liquid hydrogen propellant J-2X rocket engine, combustion instabilities were observed near the frequency of the first longitudinal acoustic mode of the hot gas combustion chamber duct. These instabilities were similar to intermediate-frequency or buzz-type instabilities as described in historical programs, except for several aspects: 1) the frequencies were low, in the realm of chug; 2) at times the instability oscillation amplitudes were quite large, with peak-to-peak amplitudes exceeding 50% of the mean chamber pressure along with the appearance of harmonics; 3) the chamber excitation was related to but not exactly at the first longitudinal combustion chamber acoustic mode; and 4) the injector provided mass flow rate oscillations induced by capacitance and inertance effects in the injector rather than by organ pipe resonances of the coaxial oxidizer posts. This type of combustion instability is referred to as "injection coupling" because one critical driving source of the instability is mass flow rate oscillations from the injector. However, the type of injection coupling observed here is different than observed in previous instances of buzz instability with coaxial injectors, because of the lower frequencies and lack of influence from the oxidizer post organ pipe resonances. Test data and preliminary analyses of the initial combustion instabilities were presented in several papers at the 5th Liquid Propulsion Subcommittee meeting. Since that time, additional hot-fire tests with several new hardware configurations have been conducted, and additional analyses have been completed. The analytical models described in previous papers have been updated to include the influences of new geometrical configurations, including a different oxidizer injector manifold configuration and a branch pipe in the hot gas duct that supplies gaseous helium during the start transient to pre-spin the turbine. In addition, the analysis methodology has been revisited to evaluate the potential influence of a combustion response as well as an injection response.